A TYPICAL CASE OF STREAM-CAPTURE IN MICHIGAN.[1]

THE geographic relations of the phenomena to be described herein are shown in the accompanying map (Fig. 1). The wider relations are shown in the smaller map, the particular location being near Rawsonville, east of Ypsilanti, Mich.; while the more special relations are shown in the larger map.

The least modified and most typical remnant of the captured valley to be described is shown in Fig. 2—a view taken from the point *A* on the larger map, and embracing the upper part of what is now the Oak Run valley. The valley seen in the foreground has a typical trough-like configuration, with very definite slopes which make a distinct angle of 20° with the flat and marshy valley floor. No stream, however, flows through this portion. In the middle distance the valley floor terminates abruptly on the side of a deeper valley. The termination is given artificial distinctness by a roadway crossing at this point which has been raised about three feet on account of the marshiness of the valley floor. Nearly opposite this abrupt end of Oak Run valley, another valley, Oak Ravine, comes in obliquely from the right, as partially shown by the snow-covered slope near the group of elms in the middle of the picture. This valley heads in a clump of oaks, the tops of which are visible in the right background. The drainage of the valley is discharged opposite the truncated head of Oak Run valley. At the point of their nearest approach, in the left center of the view (Fig. 2), Oak Run and Oak Ravine are intercepted by an embayment of the Huron River flood-plain, whose bluffs are here about forty-five feet high. This embayment was made by a meander of the Huron River which cut back into the drift-plain of the region about a quarter of a mile, and reached the line of the two valleys in question (see map, Fig. 1). This drift plain constitutes the horizon in Fig. 2, and the bluff of the embayment is partially shown at the left below the barn.

[1] I am greatly indebted to Professor M. S. W. Jefferson for the accompanying photographs and for helpful suggestions in the preparation of this paper.

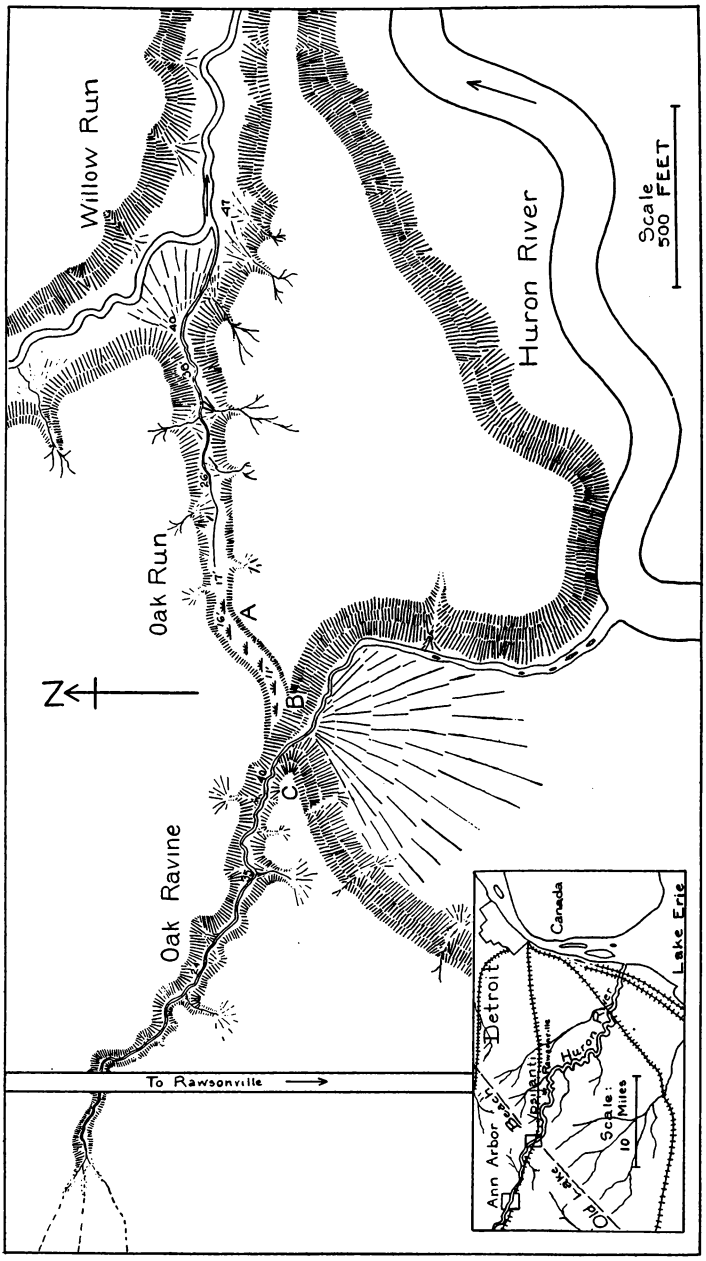

FIG. 1.—Map of Beheaded Oak Run.

When the encroachment of the bend of the Huron River began, Oak Ravine constituted the upper part, and Oak Run the lower part of a single valley, discharging into Willow Run; but when the right bank of their common valley had been broken down by the attack of the Huron, the waters of the headward portion were diverted and cascaded down the bluff of the embayment to the Huron below, while

FIG. 2.—Oak Run Valley where headwaters are taken out to left.

the part of the channel seen in the foreground of Fig. 2 was left a marshy flat. At the present time these two valleys, once continuous, have a difference of elevation of thirty feet, due to the erosion of the bottom of the upper section, while the head of the lower section has not been appreciably lowered.

The drainage area of the lower section, now the valley of Oak Run, is very small, probably less than 100 acres. The drainage area of the diverted upper section is several hundred acres. The difference in the erosion since the disseverance of the valley has brought the configuration of the two portions into sharp contrast. That of the lower portion at its head, where erosion has practically

stopped, has already been noted. That of the upper section, near its mouth, is shown in Fig. 3—a view taken from the point *B* on the map (Fig. 1) and looking westward up the valley.

The captured upper portion of Oak Ravine.—It will be noted that

FIG. 3.—Oak Ravine—the deepened headwater valley of Oak Run.

this upper portion has the sharp characteristics of youth. The side slopes have angles as high as 25°. The stream in the bottom of the valley has no flood-plain, but hurries over rapids and little falls, giving evidence of decided youthfulness. Although pushed slightly to one side or the other by the alluvial fans built forward from the mouths of tributary gullies, it is in the main entirely competent to care for the waste creeping into it. The depth of the ravine below the upland is shown on the map at intervals of 250 feet by the numbers in the bottom of the ravine. It is seen from these numbers that

the profile of the descent is a normal curve, the flattest part being near the mouth and the steepest near the head of the ravine.

Out on the alluvial fan at the mouth of the ravine the stream finds a much gentler descent than it has previously enjoyed, and so begins to build up its bed, little sand-bars and islands showing the overloaded condition of the stream.

The heads of the tributary gullies have a characteristic amphitheatral shape. The slopes all lead to one central point from which the drainage follows a main course to the mouth of the gully. The waste slopes exhibit at present but moderate activity, although six or eight trees, prostrate because of undercutting, bear witness to the steady deepening of the ravine.

The beheaded valley, Oak Run.—The widths of the flat valley floor of Oak Run valley, expressed in feet, at intervals of 200 feet from the head, are as follows: 26, 22, 17, 16, 15, 10, 0. At the next to the last point given, Oak Run begins as a definite stream, and the valley floor gradually disappears, the valley becoming *V*-shaped, so that, standing at the mouth of Oak Run and looking upstream, one has a view similar to that shown in Fig. 3, and the stream here exhibits the same competency to remove waste, although no prostrate trees speak of great activity. On the map the numbers in the valley of Oak Run speak of abnormal valley descent, the flattest portion of the floored part of the valley being near the head. The steepening of the course continues until halfway down Oak Run, where the normal curve is assumed and maintained for the rest of the way.

The tributary gullies in the upper part of the valley have the same amphitheatral shape as those of Oak Ravine display, but farther downstream the dendritic pattern is assumed. The gullies have here gashed the upland deeply, and tons of earth are carried down them every year. Those at the head of the valley are long and gently sloping, and are gradually building up the valley floor. Those farther down push the weak stream from side to side until its increased volume enables it to pursue a more independent course. The greater part of the old watershed of Oak Run now drains into Oak Ravine, so that immediately after capture had taken place the now greatly diminished Oak Run began aggrading its valley-floor until the grade attained by the stream enabled it to carry all of the waste brought

in by tributaries and washed down from the valley sides. A part of the flat valley floor is thus accounted for; that near the head being explained by the fact that there is here no surface stream at all, but little waste has been removed, and the filling of the valley continues without interruption.

One of the clearest evidences of capture is the remnant of Oak Run valley perched on the Huron bluff and running neatly around

FIG 4.—Looking down Oak Run from across mouth of Oak Ravine.

a spur into Oak Ravine. The bench-like effect which it gives to the bluff is very clearly seen in the field, although it appears but faintly in Fig. 2 because of the distance at which the view was taken. The bluff at the elbow of capture is covered over with tufts of grass and peat sliding down from the channel of Oak Run. Wet-weather gullies are eating farther and farther back, so that the bench will finally disappear. These facts unite with other evidence presented in indicating the extreme recency of the capture.

The whole case is so complete in detail and so small in size that it furnishes at once a perfect example of this kind of stream-adjustment

and an excellent pocket specimen, as it were, for classes in field geography. Since the discovery of this example of stream-capture, a study of the map reveals evidences of other cases near Ypsilanti which will be studied in the field during the spring and summer.

Relation to examples previously discussed.—The seizure of drainage areas of weak streams by more powerful adjacent streams forms an interesting phase in physiography. Broadly speaking, two forms of stream-capture may be recognized. The one takes place gradually through the headward growing of streams flowing down the steep inface of a cuesta, the captured stream originally flowing down the gentler outface. Gilbert describes such cases in his *The Geology of the Henry Mountains*, and Heim long ago pointed out the capture of the Inn by the steep-sloping Maira. To this class belong also cases later described by Professor Davis: the capture of the upper Schmiecha by the Eilach in the Swabian Alps, piratical Deer Run in eastern Pennsylvania, and a number of cases along the Blue Ridge of Tennessee.

Kaaterskill sheet, New York, of the U. S. Geological Survey, topographic sheets, shows Plaaterskill Creek undercutting the drainage areas of a southern tributary of Scoharie Creek; while a northern tributary is being undercut by the Kaaterskill. Both the Plaaterskill and Kaaterskill run directly into the Hudson, making a descent of about 900 feet in the first few miles of their course. Scoharie Creek drains northward into the Mohawk, and so finally into the Hudson, and must descend but 900 feet in at least fifty miles. It is therefore losing territory to the more vigorous streams gnawing into the eastern border of the upland.

The river systems of the Atlantic coast owe their present extension to westward cutting. One by one the streams of the Appalachian region have been diverted to the Atlantic, until but a single river continues its original course to the Mississippi. This is the Kanawha, wearing in canyon form the marks of its long struggle against the diverting tendency.

The second form of capture is accomplished by the sideways swinging of a master-stream, which may thus eventually eat into the side of a neighboring stream or behead one of its own tributaries. It may have been in this manner that the Red River came to enter the

Mississippi at Turnbull's Island, as shown on the eight-sheet map of the alluvial valley of the Mississippi. The Red may have run right to the Gulf at one time until the meandering Mississippi bit into the valley and carried off the waters. In time of drought, the Red discharges into the Mississippi, but in flood season it discharges partly into the Atchafalaya which runs into the Gulf. Bayous at Turnbull's Island indicate a possible westward meandering in the Mississippi sufficient to produce such a result. In the same way Bayou Maçon appears to have once discharged into the Ţensas, and so into the Red, while Lake Maçon would seem to indicate that the Mississippi had cut into the river and captured it at that place. Eastward cutting in the Mississippi may then have carried the river away from Bayou Maçon, so that that stream now discharges through its old channel. Were it not for the extreme flatness of the Mississippi flood-plain, these streams would probably have continued to run into the Mississippi even after its withdrawal from the scene of capture. The silting up of the ends of the cut-offs seems on that faint grade to have been sufficient to return the streams to their old courses.

An example of capture from neighboring streams is that of the capture of the upper waters of Beaverdam Creek by the Shenandoah at Snickers Gap, as described by Bailey Willis; or the well-known capture of the upper Chattahoochee by the Savannah on the boundary between Georgia and South Carolina.

In the *National Geographic Magazine*, June, 1896, p. 189, in an article entitled "The Seine, the Meuse, and the Moselle," Professor Davis describes the capture of the Ste. Austreberte by the Seine, which, swinging past Quévillon and St. Martin, cuts into the bluffs bordering the upland at Duclair. The Ste. Austreberte is diverted from its previous course across the spur marked by the Forêt de Jumièges. The same writer describes a similar case on the Marne.

The Huron River exhibits the latter type of capture. During its youth it maintained a course, across what had been but recently the floor of a glacial-marginal lake, with strict propriety. Its tributaries flowed to the southeastward for the same reason as did the master-stream, and entered the Huron at a slight angle. The moment that the powerful Huron began swinging from side to side,

the integrity of the little streams adjacent to it began to be endangered. It must eventually happen that capture would become more and more imminent, or perhaps actually be accomplished. In this manner the Huron cut its way into the valley of Oak Run and beheaded it, being helped the sooner to this climax by a turn in Oak Run just opposite the point where the Huron has meandered so strongly.

ISAIAH BOWMAN.

STATE NORMAL COLLEGE,
Ypsilanti, Mich.